

## RE-DO CLUBFOOT: SURGICAL APPROACH AND LONG-TERM RESULTS

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**C**URRENT CONCEPTS of treatment for clubfoot deformity initially tries manipulation and serial casting,<sup>13</sup> but 30–50% of the feet will not be corrected and will need surgical correction.<sup>10,19,20,37,40,49,57,61</sup> An average of 25% (13–50%) of the operated feet will have poor results and most will require additional surgical intervention.<sup>8,9,30,34,35,41,42,43,45,47,50,57,62</sup> What are the possible causes for the 25% surgical failure rate? How should we define failure? What sorts of feet should be reoperated upon? What would be the best procedure for reintervention? At what age?

In this report we try to address these questions and to outline a surgical protocol useful in decision making for reintervention in a variety of relapsed or residual feet deformities in different age groups. We also suggest an objective functional rating system for evaluation of the results of operation.

### MATERIAL AND METHODS

During 1979–1987, a total of 200 patients with clubfoot deformities were operated upon in our hospital. 117 of those (159 feet—42 were bilateral) were operated upon personally by the senior author.

40 of the 159 feet (32 patients—25%) were revision clubfoot surgery. Six patients (eight feet) have been our own recurrences. All of the others (26 patients—32 feet) were referred to us after being operated upon once (27 feet) or twice (five feet). (Table I)

TABLE I PATIENTS, SURGICAL INTERVENTION, FOLLOW-UP

Patient	Sex	Side	Age at 1st operation	Type of surgery	Surgery done	Age at revision	Type of revision	Re-revision	Age	Follow up	Remarks
G.S.	M	Bil.	9 m	Bil. post. release	Elsewhere	5 y 11 m	L STCFR D.E.	—	—	25 m	Distal arthrogyposis T-C bar
F.L	M	Bil.	6 m	Bil. post. release	Elsewhere	5 y 8 m	R STCFR D.E.	—	—	34 m	
						5 y 9 m	L STCFR D.E.	—	—	33 m	
R.N.	F	L	6 m	PMR	Elsewhere	6 y 10 m	STCFR D.E.	Plantar rel. + metat osteotomy	9 y 10 m	44 m	T-C bar
G.A.	M	R	6 m	PMR	Elsewhere	5 y 2 m	STFCR D.E.	Re fusion C.C.	5 y 8 m	38 m	T-C bar
B.M.	M	R	4 m	PMR	By us	4 y 8 m	STCFR + D.E.	—	—	9 m	T-C bar
T.J.	M	Bil	4 m	B PMR	By us	4 y	R STCFR + D.E. L STCFR + D.E. + T.A. transf.	—	—	9 m	Imperforated anus, hemi-vertebra L3, scoliosis

V.R.	M	Bil	R 5 y L 7 y	Post. Release	Elsewhere	11 y	B STCFR Steindler + D.E.	—	—	44 m	—
W.E.	F	Bil	8 m	B PMR	By us	4 y	R STCFR + D.E.	—	—	34 m	—
							L Tarsometat. capsulotomies + Steindler				
S.M	M	R	6 m	PMR	Elsewhere	3 y 2 m	STCFR	—	—	70 m	—
T.M.	M	R	5 m	Post. Rel.	Elsewhere	1 y	STCFR	—	—	33 m	—
D.B	M	R	7 m	PMR	Elsewhere	1 y	STCFR	—	—	27 m	—
W.C.	F	R	18 m	PMR	Elsewhere	2 y	STCFR	—	—	65 m	—
L.J.P.	M	L	6 m	PMR	Elsewhere	2 y 6 m	STCFR + Steindler	—	—	61 m	—
R.J.	M	Bil	8 m	B PMR	Elsewhere	2 y	L STCFR + Steindler + Capsulotomies C-C, N 1st cun	—	—	14 m	—
K.G.	M	L	3 m	PMR	Elsewhere	3 y	STCFR + Steindler + C-C Capsulotomies + lat. T,N,	—	—	49 m	—

1 y RE PMR + Tarsometatar. capsulotomies											
G.D.	M	Bil	6 m	L PMR	Elsewhere	4 y	R STCFR + Steindler C-C Capsulotomies + lat. T-N	—	—	13 m	—
			11 m	R PMR							
C.J.	M	L	1 y	PMR	Elsewhere	3 y	STCFR + Split T.A. transfer	—	—	55 m	T.C. bar
R.R.	F	R	7 y	PMR	Elsewhere	12 y	Post rel. + TAL	—	—	36 m	—
C.J.	M	Bil	2 y	B post. rel	Elsewhere	6 y 8 m	B Tarsomet. cap- sulotomies + abduct. hal. res.	—	—	—	Polydactyly L hand
			6 y	B PMR							
P.J.	M	L	5 m	PMR	Elsewhere	6 y 3 m	Tarso. metatar. capsulotomies + Steindler + abd. hal. res.	—	—	40 m	Lymphocytic leukemia
R.J.	M	L	8 m	PMR	By us	6 y	D.E. + abduct. hal. res.	—	—	9m	—
L.I.	M	L	9 m	PMR	By us	5 y 9 m	D.E. + tarso metatar. cap- sulotomies	—	—	18 m	—

T.M.	M	Bil	3 m	B PMR	Elsewhere	7 y 10 m	L Dwyer + Stein- dler	Re Dwyer B.G.	8 y	67 m	—
T.M.	F	Bil	1 y	B PMR Z plasty constricting band R	Elsewhere	9 y	R triple arthrodesis + metat. osteo- tomies	—	—	77 m	Constricting band R leg

*Legends:* Bilateral (B), Soft tissue clubfoot release (STCFR), Dillwyn Evans (D.E.), Calcaneo cuboid (C-C), Posterior release (Post rel), Talo navicular (T-N), Navicular first cuneiform (N-1st cun), Posterior medial release (PMR)

All of them were considered poor results by subjective evaluation of the appearance, motion, pain, and gait as well as by objective clinical assessment, according to several suggested functional rating systems<sup>8,40,41,42,58,61</sup> and our own functional rating system, which will be explained in detail later. Only 24 patients (70%, 29 feet—five bilateral) could be retrieved for this study (which is not unusual).<sup>30</sup> Of these, 19 were male and five female. Age at revision ranged from one year to 12 years (average: 5 y 4 m). The time period from previous surgery was 5 months to 8 years (average: 3 y 8 m). Previous surgery included 20 posteromedial releases and four posterior releases.

### FOLLOW-UP

For 22 feet follow-up was 25 to 84 months (average: 36 months), for seven feet follow-up was nine to 18 months (average: 12 months).

As we can see from Table I, the surgical method most commonly used for revision clubfoot was repeat complete soft tissue clubfoot release as the only procedure or combined with the Dillwyn Evans operation, plantar release and/or capsulotomies (navicular-first cuneiform, first metatarsal joints (Figures 1a, 1b, 2a, 2b, 2c, 2d).

In a typical revision soft tissue clubfoot release, the usual finding was heavily scarred tissue in which the neurovascular bundle, the flexor hallucis longus tendon, flexor digitorum tendon, tibialis posterior tendon, and achilles tendons were embedded. The neurovascular bundle was the first structure to be dissected free throughout its course, proximal to the ankle and distal to the sole of the foot. The tibialis posterior, flexor hallucis longus, flexus digitorum, achilles, and abductor hallucis tendons were excised. Then followed capsulotomies of the posterior ankle joint, the subtalar joint on its posteromedial side and the talonavicular joint on its superior, inferior, and medial sides. If at this stage correction of the deformity was not achieved, we added a Steindler plantar release and capsulotomies of the navicular-first cuneiform and first cuneiform-first metatarsal joint as needed. The interosseus ligament, if found, was resected.

If the forefoot part of the deformity was not fully corrected, then through a lateral incision the calcaneo-cuboid joint was opened and excised or fused, depending on the age of the patient.<sup>1,18,56</sup>

### RESULTS

In evaluating results of clubfoot and revision clubfoot surgery, it should be emphasized that even the best results cannot be regarded as a normal looking

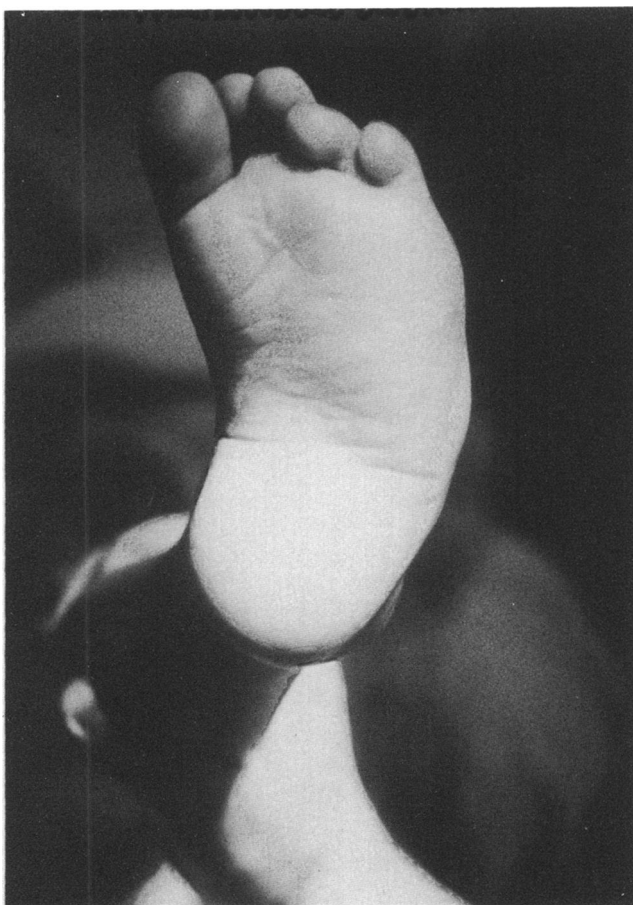


Fig. 1a. F.L. Five years after posterior release, before revision (re-soft tissue club foot release and Dillwyn Evans operation)

foot because shortening of the affected foot and hypoplasia of the calf are constant and permanent symptoms.<sup>35,51,58</sup> After a second or even third intervention, one would expect the hypoplasia of the calf as well as the shortening of the affected foot to be even more significant. However, in our patients the figures were the same as those reported after one intervention:<sup>35,61</sup>

*Shortening of the affected foot*

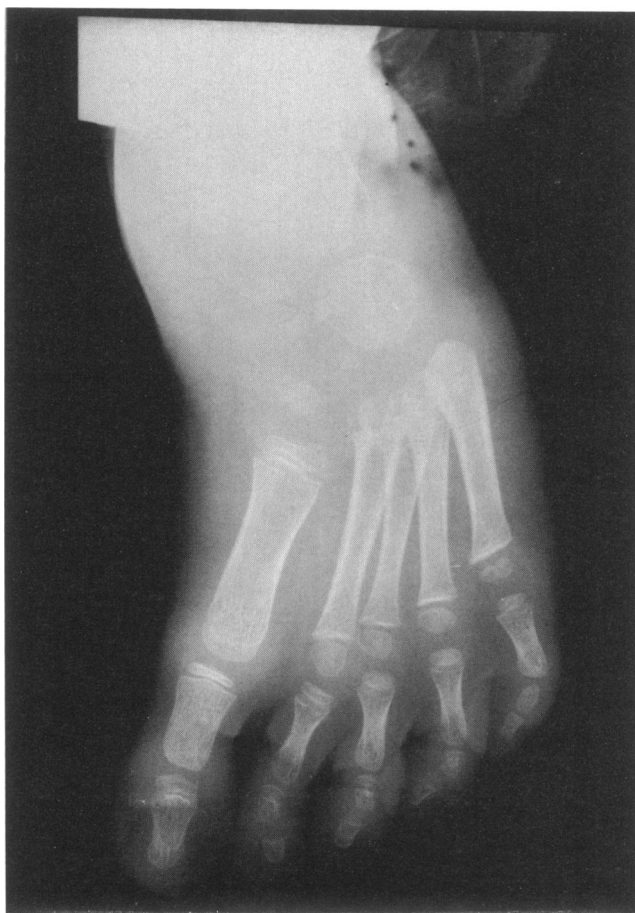
Range: 0 cm. to 4 cm. (average: 1.6 cm.)

*Difference between the width of the feet*

Range: 0 cm. to 0.6 cm. (average: 0.3 cm.)

*Difference between the circumference of the calves*

Range: 0 cm. to 5.5 cm. (average: 2.5 cm.)



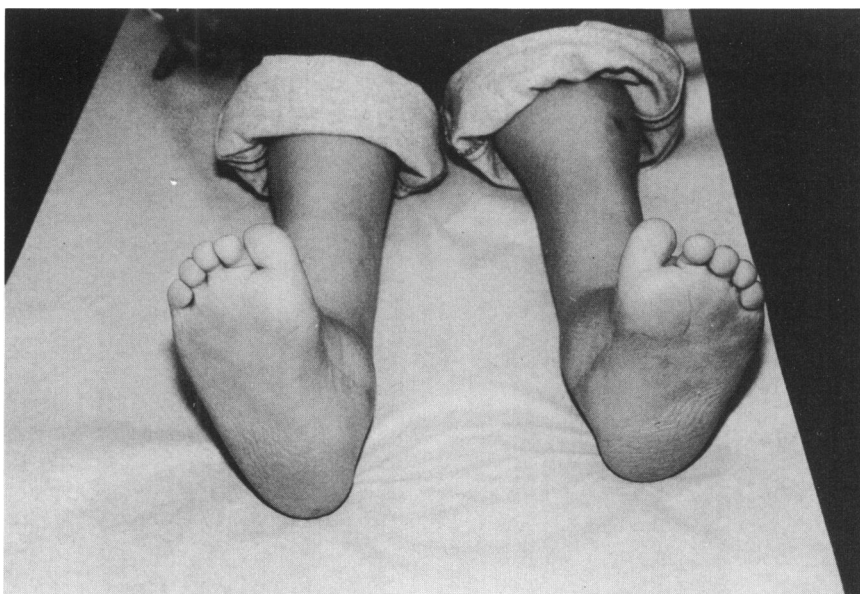
1b. F.L. Roentgenogram before revision talus-met. 1 angle 40°

Flat top talus, wedged and slightly dorsally displaced navicular bones as well as substantial subtalar changes were found in all our patients (Figure 3). The same findings were documented by many authors after conservative and operative treatments of club feet.<sup>5,12,15,30,48,54,60</sup>

To evaluate the overall results of the treatment of congenital clubfeet, several functional rating systems have been suggested. Most consist of subject evaluation of appearance, motion, gait, and pain.<sup>8,41,43,61</sup> Some add radiographic criteria as well.<sup>6,19,21,45,58</sup> No standardized method to evaluate the results of treatment has been widely accepted.

In our hospital we designed our own functional rating system that includes objective clinical assessment, subjective and radiographic criteria. The sys-





**Fig. 2a.** Three years later, plantar view



**2b.** Three years later, posterior view



2c. Roentgenogram three years later; fusion of calcaneo-cuboid joint talus-metatarsal.  
l angle 20°

tem is in current use to evaluate results of club feet and revision club foot surgery (Tables II and III).

A total score of 100 points indicates a normal foot. This includes a maximum score of 15 for range of ankle motion and function. Ten points each for subtalar motion, position of the heel when standing, gait, appearance of the forefoot, pain and radiographic appearance and 5 points each for type of shoes and satisfaction. A classification of excellent would be 85–100 points, good would 70–84 points, fair would be 60–69 points, and poor would be less than 59 points.

As can be seen from Table III, we had eight excellent results, 11 good results, eight fair results, and two failures. If we include fair as an acceptable



2d. Same roentgenogram—lateral view: Note the fusion of the calcaneo-cuboid joint



Fig. 3. L.J.P. age eight years (five years after reoperation): Note the flat top talus, the subtalar changes and the wedge navicular

TABLE II. FUNCTIONAL RATING SYSTEM FOR CLUBFOOT SURGERY

Category	Points	Category	Points
1) Ankle dorsiflexion (passive motion)		6) Radiograph	
More than 90°	15	*T-C index 40° or more	5
90°	5	Less than 40°	0
Less than 90°	0	T-Met-1st angle 10° or less	5
		More than 10°	0
2) Subtalar joint (passive motion)		7) Shoes	
15° or more	10	Regular—no complaint	5
Less than 15°	5	Regular—with complaints	2
Stiff	0	Orthopaedic shoe/inserts/braces	0
3) Position of the heel when standing		8) Function	
0–5° valgus	10	No limit	15
More than 5° valgus	5	Occasional limits	8
Varus	0	Usually limited	0
4) Forefoot (appearance)		9) Pain	
Neutral	10	Never	10
Less than 5° add/abd	5	Occasionally	5
More than 5° add/abd	0	Usually	0
5) Gait (Total 10)		10) Satisfaction	
Normal	6	Very satisfied	5
Heel walk	2	Partially satisfied	3
Toe walk	2	Unsatisfied	0
Abnormal heel/toe sequence	0		

\*T-C index is the sum of the T-C angle lateral + AP

TC = talocalcaneal, T-Met-1st = talus first metatarsal angle

result, then our overall satisfactory result would be 93%.

The procedures mostly used were soft tissue clubfoot release alone or with plantar or Dillwyn Evans operation, or capsulotomies (total of 21/19—79%) with average score of 83 (range: 74–95). In those cases with tarsometatarsal capsulotomies (3/29), the average score was 63, which is in agreement with the literature.<sup>53</sup>

Three patients with underlying diseases or syndromes had poor results: constricting ring, lymphocytic leukemia and a syndrome with imperforate anus, hemi-vertebra L3, and scoliosis. Score range: 47–70 (average: 58). In four patients overcorrection (heel valgus more than five degrees) was the prominent cause for fair/poor results. Score range: 47–66 (average: 59).

## DISCUSSION

The range of poor results in clubfoot surgery is 13–50% (average: 25%).<sup>8,9,30,35,41,43,45,47,50,57,62</sup>

TABLE III. RESULTS OF REVISION CLUBFOOT SURGERY ACCORDING TO THE FUNCTIONAL RATING SYSTEM

Category	1	2	3	4	5	6	7	8	9	10	Score
G.S.	15	5	10	10	8	10	5	15	10	5	93
F.L.	15	10	10	10	8	5	0	8	5	3	69
	15	10	10	10	8	5	0	8	5	3	69
R.N.	15	0	10	5	8	10	5	15	10	5	83
G.A.	15	0	10	10	8	10	5	15	10	5	93
B.M.	15	10	10	10	8	0	0	15	10	5	83
T.J.	15	10	10	5	2	5	0	8	10	5	70
	15	10	0	5	2	5	0	8	10	5	60
V.R.	10	5	10	10	8	10	15	15	10	5	88
	10	5	10	5	8	5	5	15	10	5	78
W.E.	15	10	10	10	8	10	5	8	5	3	84
	15	10	10	10	8	10	5	8	5	3	84
T.M.	15	5	10	5	8	10	5	15	10	5	83
D.B.	15	5	10	10	6	10	5	15	10	5	91
W.C.	5	10	0	5	10	10	5	15	0	3	63
L.J.P.	15	0	10	5	8	10	5	15	10	5	83
R.J.	15	10	0	5	8	10	0	8	5	5	66
K.G.	15	5	10	10	8	10	5	15	10	5	93
G.D.	5	5	10	5	10	10	5	15	10	5	80
C.J.	15	0	10	5	10	10	5	15	10	5	85
R.R.	15	10	10	10	10	10	5	15	5	5	95
C.J.	5	0	10	5	8	10	5	15	10	5	73
	5	0	0	5	8	10	5	15	10	5	63
P.J.	5	5	10	0	8	5	5	8	5	3	54
R.J.	15	5	10	5	8	10	0	8	5	5	71
L.I.	15	0	10	5	8	0	0	8	10	5	61
T.M.	15	5	10	5	8	5	0	8	15	3	64
T.M.	5	0	0	5	2	5	5	15	5	3	47
S.M.	15	10	10	5	10	10	5	15	10	5	95

What are the possible causes for this substantial surgical failure rate? We can suggest some possible explanations. *Incomplete initial clubfoot release.* In 22% of our revised clubfeet we found talo-calcaneal bars (bony or cartilaginous) that might be an important contributing factor to recurrency. The bars might be iatrogenic (injury to the subtalar joint during previous surgery) or overlooked during the previous procedure. In all the revised feet that we operated on, where Z lengthening of the flexor tendons and the tibialis posterior were done, the tendons were scarred and nonfunctioning. This might contribute to the recurrent deformity. We now prefer to perform fractional lengthening of those tendons as reported elsewhere.<sup>3</sup> *Overcorrection* (heel valgus) is another cause for a poor result. It seems that the integrity of the interosseous ligament plays an important role in prevention of this disabling deformity. *Infection* (scar formation), inadequate postoperative treatment by

TABLE IV. ALGORITHM FOR RESURGICAL INTERVENTION IN CLUB FEET

<i>Age at revision</i>	<i>Method of treatment</i>
6 months to 2 years	<ol style="list-style-type: none"> <li>1) Repeat complete soft tissue clubfoot release</li> <li>2) If prominent plantar crease, add plantar release</li> <li>3) If FFA not corrected—add capsulotomies, N-Cun-First metatarsal as needed (See details in <i>Method &amp; Materials</i> section of this report)</li> </ol>
2 years to 4 years	<p>Follow steps 1,2,3,</p> <ol style="list-style-type: none"> <li>4) If FFA not corrected, add excision of cartilage of C-C joint<sup>56</sup> or decancellation of cuboid<sup>44,52,55,59</sup></li> </ol>
4 years to 8 years	<p>Follow steps 1,2,3</p> <ol style="list-style-type: none"> <li>5) If FFA not fully corrected, add <ol style="list-style-type: none"> <li>a) Fusion of C-C joint (D.E.)<sup>1,18,56</sup></li> <li>b) or excision of distal calcaneus (Lichtblau)<sup>39</sup></li> <li>c) or cuboid decancellation<sup>44,52,55,59</sup></li> <li>d) or open wedge osteotomy first cuneiform<sup>28</sup></li> <li>e) or tarso metatarsal capsulotomies<sup>*27</sup></li> <li>f) or metatarsal osteotomies (over age 5)<sup>7</sup></li> </ol> </li> <li>6) If overacting tibialis anterior vs. weak peroneal—add tibialis anterior transfer<sup>31</sup></li> <li>7) If heel varus still not corrected, add Dwyer<sup>16,17</sup></li> </ol>
Over age 8	<p>Up to age 10 possible to start with Steps 1,2 and then proceed according to deformity remaining—</p> <p>Calcaneus: Stage 7</p> <p>FFA: Stage 5 A,B,C,F</p> <ol style="list-style-type: none"> <li>8) Persistent cavus—mid tarsal osteotomy</li> <li>9) Distraction osteogenesis (Ilizarov) as the only procedure</li> <li>10) Over age 10 years—triple arthrodesis as the only procedure<sup>29,32,36</sup></li> </ol>
In overcorrected foot (valgus heel)	
For the flexible type:	<p>Less than 4 years—conservative treatment: UCB, AFO</p> <p>4 to 10 years—subtalar arthrodesis (Grice, Dennyson)<sup>14,24</sup></p> <p>Over 10 years—triple arthrodesis</p>
For the rigid type:	<p>Less than 4 years—repeat complete soft tissue clubfoot release</p> <p>4 to 10 years—repeat soft tissue clubfoot release plus subtalar arthrodesis</p> <p>Over 10 years—triple arthrodesis or distraction osteogenesis (Ilizarov)</p>

\*Not recommended by literature<sup>53</sup> and our experience

the surgeon as well as noncompliant parents are also common reasons for surgical failure.

What would be the best surgical procedure for the relapsed or the residual deformity? And at what age? During the fast few years with accumulation of

experience we have developed a surgical algorithm that proved useful in decision making for the re-operated clubfoot (Table IV). We hope that our protocol of treatment and our functional rating system will help orthopedic surgeons properly to address this increasing problem of revision club foot surgery and to evaluate long-term results.

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